

Sydney Tar Ponds

Clean-Up

Funded By The Canada/Nova Scotia Subsidiary Agreement
Dated November 7, 1986

Atlantic Regional Library
Environment Canada

OCT 16 1998

Bibliothèque de la région
de l'Atlantique
Environnement Canada

SHORELINE INVESTIGATION REPORT

February 1989

ENVIRONMENT CANADA LIBRARY
15th Floor, Queen Square
45 Alderney Drive
Bartmouth, N.S. B2Y 2N6
CANADA



Acres International Limited

TABLE OF CONTENTS

LIST OF TABLES
LIST OF FIGURES

	<u>Page</u>
1 - INTRODUCTION	1
2 - STUDY PROGRAM	3
2.1 - Field	3
2.2 - Laboratory	4
3 - SUBSURFACE CONDITIONS	6
3.1 - Southeast Shoreline of Upper Tar Pond	6
3.2 - Centennial Mall Property	8
4 - DEGREE OF CONTAMINATION	11
5 - RECOMMENDATIONS	14

REFERENCES

APPENDIX A - DRILLING REPORTS

LIST OF TABLES

<u>No.</u>	<u>Title</u>
1	Description of Borehole Samples Selected for PAH Analysis
2	PAH Distribution by Compound

LIST OF FIGURES

<u>No.</u>	<u>Title</u>
1	Site Plan
2	Cross Section A-A'

1 - INTRODUCTION

Acres International Limited (Acres) was commissioned by the Nova Scotia Department of the Environment (NSDOE) to provide project management services for the clean-up of the Tar Ponds at Sydney, Nova Scotia. One concern raised regarding this clean-up was whether tar pond type materials may be present within, or under, the fill bordering the southeast shoreline of the upper Tar Pond, and thus represent a possible long-term contamination problem. This area is of particular concern because the old shoreline prior to 1900 extended inshore from the present location (see Figure 1). There was a concern that tar pond materials may underlie this area as a result of disposal of these materials into Coke Oven Brook prior to infilling. A similar concern was raised for the area surrounding the Centennial Mall Shopping Center. The possibility existed that tar ponds materials could have been dumped at this site owing to the fact that it was originally a low-lying wet area which required fill materials to reach its existing grade.

To address the above, an investigation was carried out in late November 1988. The program involved the drilling of boreholes to determine the local stratigraphy and, specifically, identify any PAH-contaminated horizons. This report provides a summary of the field work and related soil analyses. Chapter 2 outlines the field methods used and laboratory analyses performed while Chapter 3 provides a description of the subsurface conditions. Chapter 4 follows with a description of the degree of PAH contamination along the shoreline. Recommendations arising from this investigation are summarized in Chapter 5.

2 - STUDY PROGRAM

2.1 - Field

A total of nine boreholes were drilled along the southeast shoreline of the upper Tar Pond/Wash Brook (Figure 1) during the period November 18 - 21, 1988. The location of the six boreholes along the southeast shoreline of the upper Tar Pond (BH1 to BH4, BH8 and BH9) were selected to fall within the old channel of Coke Oven Brook, or on the seaward side of the shoreline of Muggah Creek prior to 1900. Three boreholes (BH5 to BH7) were situated on the north, west and south perimeter of Centennial Mall.

All drilling operations were carried out by Longyear Canada Inc. of Moncton, New Brunswick under the direction and supervision of Acres personnel. All boreholes were drilled with 95-mm I.D. hollow stem augers using a track-mounted CME 55 drill rig. Augering was only taken to the desired depth interval, or to refusal. No further advancement of a borehole was permitted with a core barrel. This limitation was to avoid the potential for loss of contaminated water at the ground surface. All auger flights were steam cleaned by Island Steam Cleaning of Sydney, Nova Scotia. This operation was carried out at the northwest corner of the upper Tar Pond ensuring that the wash water flowed into Muggah Creek. The drill rig, muskeg carrier and all associated equipment were similarly steam cleaned at the conclusion of the drilling operation.

Soil samples were collected in overburden with the use of a 35-mm I.D. split tube sampler. Samples were generally taken discontinuously (usually two 0.6 m lengths of core in a 1.5 m interval). All soil samples were examined and logged in the field,

stored in glass bottles and then later transferred to a refrigerator. Between sampling operations, the split tube sampler was immersed and thoroughly scrubbed in a container of soapy water and then rinsed with distilled water. Details of the borehole logs are provided in Appendix A.

2.2 - Laboratory

Following completion of the field work, 20 soil samples were selected for PAH analysis. Table 1 is a summary of the depth interval and soil type corresponding to each of these samples. Research and Productivity Council of Fredericton, New Brunswick performed the chemical analysis.

TABLE 1**DESCRIPTION OF BOREHOLE SAMPLES
SELECTED FOR PAH ANALYSIS**

<u>Borehole No.</u>	<u>Sample No.</u>	<u>Approximate Elevation (m asl)</u>	<u>Soil Type</u>
1	AQ 5	0.92 to 0.72	sand
2	AQ 3	4.48 to 3.87	coal
	AQ 10*	-0.71 to -1.31	coal and slag
	AQ 12*	-1.92 to -2.48	" " "
	AQ 13	-2.53 to -3.14	sandy silt
3	AQ 1	8.50 to 7.89	coal and slag
	AQ 11	0.88 to 0.27	" " "
	AQ 13B*	-0.95 to -1.25	coal
4	AQ 2	1.09 to 0.48	slag and coal
	AQ 4*	-0.43 to -0.71	gravel
5	AQ 1	1.40 to 0.79	concrete, slag and coal
	AQ 4A*	-0.43 to -0.71	sandy silt
	AQ 5	-1.35 to -1.96	sand
6	AQ 2	0.63 to 0.48	clayey silt
7	AQ 3	0.60 to 0.54	sandy silt
8	AQ 3	3.05 to 2.44	coal
	AQ 6A*	-1.52 to -1.98	"
	AQ 6B	-1.98 to -2.13	clayey silt
9	AQ 2*	-0.74 to -1.35	gravel
	AQ 3B	-1.68 to -1.96	sand silt

*visible coal-tar contamination

3 - SUBSURFACE CONDITIONS

In general, the unconsolidated deposits along the southeast shoreline of the upper Tar Pond/Wash Brook consist of varying amounts of coal, slag and other materials occurring as a fill deposit, which in turn are underlain by a silt/sand layer and then till.

These overburden strata are described in the following sections. This discussion is divided into two parts; the area bordering the upper Tar Pond north of Prince Street (BH1 to BH4, BH8 and BH9) and the Centennial Mall property bordering Wash Brook (BH5 to BH7).

3.1 - Southeast Shoreline of Upper Tar Pond

This part of the shoreline is flat and low-lying both north of Coke Oven Brook and in the area bounded by Muggah Creek, Prince Street and the bus depot. Between these two areas, the shoreline is hilly and irregular in shape.

At all boreholes, the uppermost layer is a fill deposit consisting of a heterogeneous mixture of coal particles and slag with some brick fragments. Incorporated within these materials are varying amounts of reddish to grayish brown sandy silt to sandy gravels. This fill deposit is typically dry to moist near the surface, becoming wet with depth, and loose to compact in density. Its thickness varies from about 2 m at boreholes BH1,

BH4 and BH9 to at least 8 m at boreholes BH2, BH3 and BH8. Coal particles are more abundant in this deposit at boreholes BH2 and BH8.

At borehole BH1, the fill deposit is underlain by a firm dark brown organic layer of sandy silt. This in turn overlies a thin (0.2 m) layer of black sand which exhibited a slight tarry smell.

At boreholes BH4 and BH9, a generally compact gravel layer coated with tar pond materials was found beneath, or as an extension of, the fill deposit. Its thickness varies from about 0.3 m at borehole BH4 to about 1.4 m at borehole BH9.

At boreholes BH2, BH3 and BH8, the lower part of the fill deposit itself is contaminated (i.e. coal and slag materials). The thickness of the contamination is about 2 m at both boreholes BH2 and BH8. The thickness is greater than 0.3 m at borehole BH3, but could not be confirmed at this location due to a breakage and loss of the split tube sampler down the hole. A firm, light brown organic layer of clayey silt (about 0.6 m) lies between the fill deposit and the underlying till at borehole BH8.

Till forms the basal deposit at all of the boreholes along the southeast shoreline. It consists of compact to dense dark brown to light reddish brown sandy silt with some gravel and a trace of clay.

The boreholes did not indicate any tar ponds material in the fill deposit above the water table (i.e. approximately sea level). Therefore, the contaminated material appears to be

✓ an extension of the upper Tar Pond itself as opposed to incorporation within fill materials which were then used to infill the area. The lower part of the fill deposit is contaminated owing to the fact that the tar pond deposits existed prior to infilling. The above stratigraphic relationship is illustrated in cross-sectional diagram A-A' (Figure 2) drawn along the assumed former channel of Coke Oven Brook and running parallel to the 1900 shoreline (see Figure 1). As can be seen from this diagram, the upper surface of the contaminated deposit closely coincides with mean sea level, or the upper surface of the adjacent Tar Pond.

3.2 - Centennial Mall Property

The area around the Mall is low-lying and flat. Elevation varies from about 1.5 m near Wash Brook to about 3 m at the east end of the Mall buildings.

A heterogeneous mixture containing any of the following materials was encountered immediately below the asphalt pavement at all three boreholes (BH5, BH6 and BH7) drilled on the Mall property.

- light gray fine gravel size slag and concrete fragments
- black sand to fine gravel size coal particles.

This fill deposit is compact and about 1.2 m in thickness at boreholes BH5 and BH6, while at borehole BH7 it is dense and 1.7 m thick. The absence of coal accounts for its more dense nature at this latter borehole.

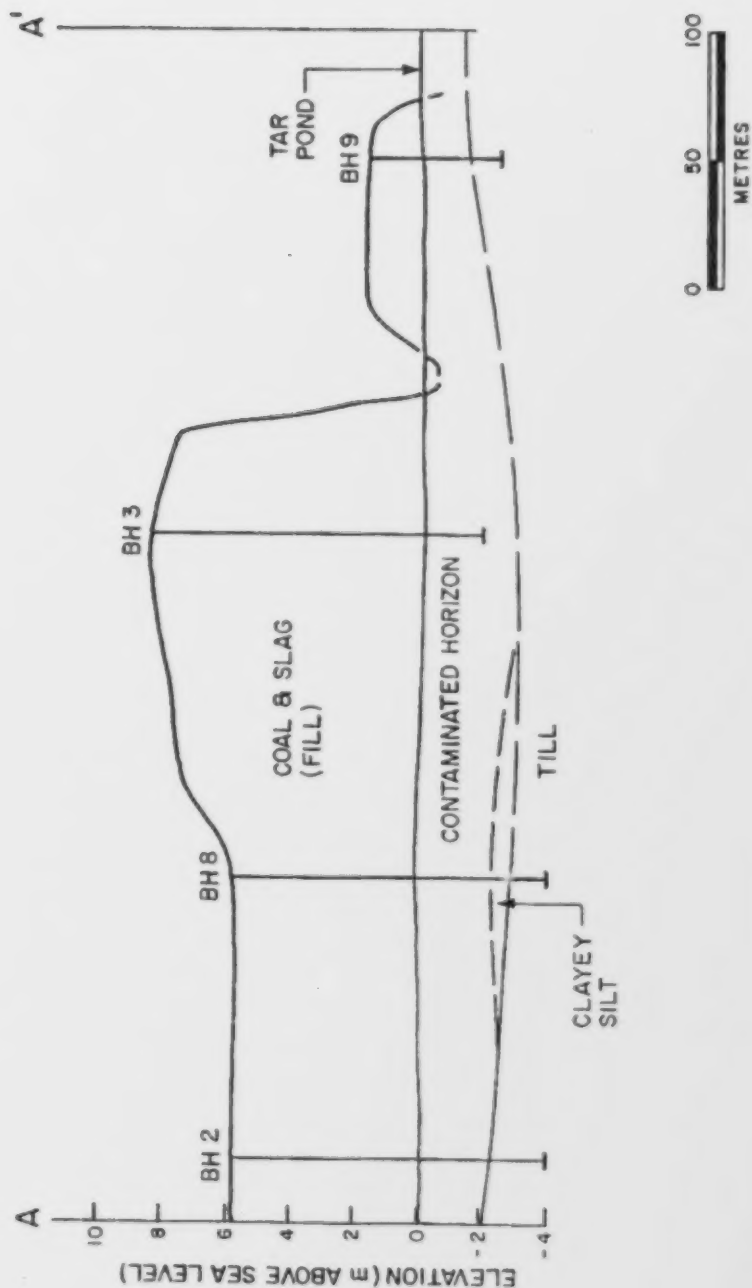


FIG. 2

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT
SYDNEY TAR PONDS CLEAN-UP

SHORELINE INVESTIGATION - CROSS SECTION A-A'





FIG. 1

NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT
STONEY TAY POND CLEAN-UP

SHORELINE INVESTIGATION - SITE PLAN



At boreholes BH6 and BH7, a relatively thin (<0.5 m) organic layer consisting of a firm, dark gray clayey or sandy silt underlies the fill deposit. This in turn is underlain by a compact to dense, dark brown to light reddish brown till. Tar pond materials were not encountered in these two boreholes.

At borehole BH5, a very loose contaminated layer of silt to fine sand lies beneath the fill deposit. This layer is tarry and about 1.2 m thick. Beneath the contaminated layer lies a 2-m thick loose, brownish gray sand which in turn is underlain by till. The contaminated layer appears to be an upstream extension of the upper Tar Pond materials, therefore suggesting the old shoreline extended further landward than shown on Figure 1. Previous observations made in an excavation trench running along the west side of the Mall did not identify tarry materials typical of that in borehole BH5 (H. Ryder - personal communication).

Based on these observations it appears likely that the contaminated deposit at borehole BH5 would not extend much further inland.

4 - DEGREE OF CONTAMINATION

Table 2 presents the results of the PAH analysis corresponding to the 20 soil samples listed in Table 1. Based on these test results, the soils underlying the contaminated zone along the shoreline are considered to be uncontaminated. These soils consist either of till (boreholes BH2 and BH9), clayey silt (borehole BH8) or sand (borehole BH5). In all of these cases, the total PAH in the soil varied from less than 1 mg/kg to slightly over 7 mg/kg. These results are comparable with that found in clayey silt and till beneath the Tar Ponds (Acres, 1987).

Similarly, the overlying fill materials (largely coal and slag) or organic silts had levels of PAHs that, although higher than normally found in soils, are likely typical of similar material in this area. The organic silts from two soil samples indicated total PAH concentrations of 23 and 34 mg/kg. Total PAHs from six soil samples of granular slag and/or coal particles which exhibited no olfactory signs of contamination ranged from less than 10 to slightly over 100 mg/kg.

The contaminated soils along the shoreline (i.e. immediately below the water table) exhibited the widest range in PAH values. Concentrations in seven soil samples, all exhibiting the typical physical signs of contamination (tarry smells, sheens), ranged from less than 30 mg/kg to in excess of 3,600 mg/kg. Those samples which appeared to contain a mixture of tar pond materials and fine grained granular fill indicated total PAH concentrations in excess of 300 mg/kg. Examination of the samples from boreholes

BH4 and BH9 indicated they were obviously contaminated at the time of sampling yet the test results revealed total PAH concentrations of only 28 and 60 mg/kg. These samples, however, consist of coarse gravel coated with tar pond materials. Consequently, the concentration of PAH in the surface coating of the gravel, would be much higher than the average mass concentration. In general, the lower overall PAH totals in the shoreline contaminated materials, as opposed to that found in the Tar Ponds themselves, are likely indicative of some mixing of fill into the original deposit.

Table 2
PAH Distribution by Compound

Sample Number	naphthalene				fluorene			fluoranthene			chrysene			benzo[<i>b</i> , <i>k</i>]fluoranthene			benzo[<i>a</i>]pyrene			indeno[1,2,3- <i>cd</i>]pyrene			Total PAH (mg/kg)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
BH-1	0.12	0.58	0.19	2.44	15.5	3.84	15.10	13.00	10.70	9.63	12	3.30	5.38	2.87	2.16	1.25							96.06
BH-2	8.46	0.30	0.20	0.91	19.5	2.66	11.50	12.70	8.29	10.40	11.3	4.23	5.89	4.12	3.89	1.38							105.95
BH-3	24.80	26.40	9.99	34.80	73.3	19.90	36.40	34.60	27.70	25.00	32	9.13	16.70	9.46	7.74	3.76							389.68
BH-4	28.10	21.00	4.75	29.60	69	20.70	31.00	28.60	22.10	17.70	23.7	5.38	10.70	6.76	5.40	2.57							307.06
BH-5	0.13	0.04	0.01	0.06	0.25		0.09	0.07	0.08	0.02	0.07	0.02	0.03	0.02	0.02	0.02							0.91
BH-6	0.63	0.03	0.04	0.08	1.31	0.07	1.00	1.03	0.68	0.76	1.02	0.37	0.42	0.31	0.30	0.11							8.16
BH-7	0.42	0.03	0.09	0.24	1.35	0.26	0.24	0.44	0.72	0.65	0.34	0.26	0.31	0.05	0.12	0.06							5.58
BH-8	64.30	63.80	42.50	116.00	323	32.40	223.00	186.00	31.80	25.50	128	54.50	66.00	32.00	24.30	10.60							1401.70
BH-9	0.50	0.11	0.45	0.70	5.26	1.10	5.79	4.90	3.35	3.02	5.07	1.69	0.26	1.73	1.66	0.57							36.16
BH-10	1.03	0.03	0.79	1.52	3.9	1.41	4.04	3.56	2.64	1.85	2.7	0.81	1.36	0.90	0.78	0.50							27.62
BH-11	3.21	0.06	0.08	0.16	2.23	0.12	0.89	0.73	0.62	0.69	1.04	0.44	0.47	0.33	0.41	0.11							11.59
BH-12	44.50	3.75	34.90	54.60	106	49.40	71.80	63.20	39.30	38.10	44.5	10.40	19.10	12.70	9.96	4.75							686.96
BH-13	0.03				0.06	0.01	0.05	0.04	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.01							0.27
BH-14	1.16	0.13	0.2	0.33	4.43	1.05	5.46	3.91	2.71	3.01	4.58	1.55	2.03	1.57	1.39	0.48							34.19
BH-15	0.64	0.17	0.36	3.19	2.24	0.62	9.54	1.79	1.17	0.82	1.12	0.33	0.56	0.34	0.26	0.1							23.25
BH-16	9.18	0.18	0.65	1.01	15.2	1.69	4	2.75	0.97	1.21	0.5	0.27	0.28	0.13	0.17	0.08							38.27
BH-17	587	309	41.8	325	739	291	446	324	215	9.4	172	42.6	84.3	41.1	31	15							3653.20
BH-18	1.19	0.09	0.77	0.69	1.66	0.07	0.62	0.61	0.46	0.27	0.44	0.11	0.17	0.12	0.11	0.08							7.58
BH-19	4.4	1.95	1.98	4.41	11.1	2.23	8.59	1.89	6.01	5.41	6.73	1.35	2.36	1.77	1.55	0.47							60.20
BH-20	0.41	0.12	0.08	0.35	1.08	0.35	0.45	0.33	0.27	0.21	0.25	0.07	0.11	0.05	0.04								4.17

5 - RECOMMENDATIONS

- 1 - If a better indication of the extent and thickness of the contaminated area along the southeast shoreline is required it is recommended that further borehole drilling take place. This will also enable improved volume estimates to be made of both the contaminated material and the overlying uncontaminated fill. The location of the boreholes would be selected on the basis of confirming the inshore extent of the contaminated area. The information collected at one borehole (physical signs of contamination) would be used as a guide towards the location of the next borehole.
- 2 - Further information pertaining to the local groundwater flow system will be required as part of an overall assessment of remedial clean-up alternatives. Therefore, it is recommended that piezometers be installed in a few boreholes drilled during the above program. This will provide hydraulic information of the underlying saturated zone and thus an indication of groundwater flow direction and rates.
- 3 - To confirm that the contaminated material along the shoreline is similar in its thermal characteristics to the Tar Pond materials, it is recommended that fuel testing of contaminated soil samples be undertaken in addition to a limited amount of chemical analyses.

REFERENCE

Acres International Limited, July 1988. "Sydney Tar Ponds Clean Up, Sampling Program". Nova Scotia Department of the Environment.

APPENDIX A
DRILLING REPORTS

Nova Scotia Department of the Environment
Sydney Tar Ponds Clean Up
Shoreline Investigation

Explanation of the
Drilling Report Form

Location	All borehole locations shown on Figure 1 are relative to a grid based on a modified 3° Transverse Mercator Projection, Zone 4 central meridian, 60° 30' west longitude.
Datum	All elevations are referred to the Canadian Geodetic Datum, and are expressed in meters. All elevations are referenced to ground surface and are approximate. Elevation abbreviations: N/e - not encountered N/r - not recorded
Depth	All depths are given in meters below ground surface.
Sample Type	Indicated by two letters, the first one describing the sample method and the second one the shipping container.
Sample Numbering	The order of the numbering scheme for all samples is such that increasing numbers correspond to samples taken at increasing depth. Samples identified by the suffixes A and B refer to samples divided into two subsamples.
Sample Returned	Length in centimeters of sample core returned in sampler. A value of zero indicates no return.

Penetration Test

Wherever the strength of the soil was measured by the Standard Penetration Test, the value given is the number of blows of a 63.6 kg (140 lb) hammer falling freely over 760 mm (30 in.) required to advance a split tube sampler to the depth indicated.

Soils Description

Silts and clay less than 0.07 mm. Approximate composition of soil is expressed according to the following word-percent relationship.

<u>Term</u>	<u>Relative Quantities (%)</u>	<u>Example</u>
and	40 to 50	sand and gravel
adjective	25 to 40	
- clayey		clayey silt
- silty		silty sand
- sandy		sandy silt
- gravelly		gravelly sand
some	10 to 25	sand with some silt
trace	0 to 10	sand with trace of silt

Consistency of Cohesive Soils

<u>Consistency</u>	<u>N (from SPT)</u>
Very soft	<2
Soft	2 to 4
Medium	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	>30

Density of
Granular SoilsDensityN (from
SPT)

Very loose
Loose
Compact
Dense
Very dense

<4
4 to 10
10 to 30
30 to 50
>50

Soil Plasticity

DescriptionLiquid Limit
(%)

Low plasticity
Medium plastic
Highly plastic

<30
30 to 50
>50



Drilling Report

JOB P8186.00
HOLE BH-1
SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 14:00 Nov. 20, 1988

FINISHED 15:15 Nov. 20, 1988

METHOD OF SOIL DRILLING: Hollow stem auger

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

BEARING N/a

INITIAL DIP Vertical

OTHER DIPS N/a

GROUND SURFACE 4.3 m

ROCK SURFACE N/e

BOTTOM OF HOLE -1.49 m

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample		Size (mm)	Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.				
0.0	Sandy silt (fill)	Heterogeneous mixture of fine to medium sand- size coal particles, light orange fine to coarse sand-size slag particles and dark reddish brown sandy silt, some fine gravel, trace clay, compact and moist becoming loose and wet with depth	AZ	1	35	0.00- 0.61	53	2
								5
								9
								8
			AZ	2	35	0.61- 1.22	36	12
								14
								9
								5
			AZ	3	35	1.52- 2.13	31	1
								2
								2
								2
2.44	Silty sand (fill)	Light reddish brown to gray silty fine sand, trace clay, loose, wet	AZ	4	35	2.13- 2.74	48	2
								3
								2
								3

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrel

E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

LOGGED BY B. G. Bennett

APPROVED

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-1

SHEET 2 OF 2

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			*Type	No.	Size (mm)			
2.61	Sandy silt	Dark brown sandy silt (organic), trace clay, firm, moist, low plasticity	AQ	5	35	3.05- 3.66	36	2 3 4 3
3.38	Sand	Light greenish gray to black fine sand, loose, moist, slight tarry smell						
3.58	Sandy silt	Light reddish brown sandy silt, some fine gravel, trace clay, compact, moist (till)	AZ	6	35	3.66- 4.27	46	4 13 10 13
			AZ	7	35	4.57- 5.18	48	3 7 8 6
			AZ	8	35	5.18- 5.79	53	8 11 12 12
5.79		End of borehole						



Drilling Report

JOB P8186.00
HOLE BH-2
SHEET 1 OF 3

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 14:45 Nov. 18, 1988

FINISHED 10:15 Nov. 19, 1988

METHOD OF SOIL DRILLING: Hollow stem auger

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

GROUND SURFACE 6.0 m

BEARING N/a

ROCK SURFACE N/e

INITIAL DIP Vertical

BOTTOM OF HOLE -3.14 m

OTHER DIPS N/a

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample					Pene- tration Test
			Type*	No.	Size (mm)	Depth (m)	Ret'd (cm)	
0.0	Coal and slag (fill)	Heterogeneous mixture of fine sand to fine gravel size black coal and light reddish orange slag particles, compact becoming loose with depth, dry	AQ	1	35	0.00-	38	3
						0.61		7
								8
								11
			AQ	2	35	0.61-	23	8
						1.22		9
								10
								11
			AQ	3	35	1.52-	25	1
						2.13		2
								2
								2
			AQ	4	35	2.13-	38	2
						2.74		2
								3
								4

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrel
E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-2

SHEET 2 OF 3

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			*Type	No.	Size (mm)			
2.90	Slag and coal	Heterogeneous mixture of light brown to reddish orange silty sand size slag and black medium sand to coarse gravel size coal fragments, compact, moist	AZ	5	35	3.05- 3.66	29	2 8 10 5
			AZ	6	35	3.66- 4.17	28	5 8 6 14/51cm
		4.2 - 4.4: rubble						
4.40	Slag	Light orangey brown medium sand to fine gravel size slag particles, loose, wet	AQ	7	35	4.57- 5.18	23	3 3 3 1
			AQ	8	35	5.18- 5.79	31	7 4 2 10
5.74	Slag and coal	Black coal-tar coated fine sand to fine gravel size slag and coal particles, loose becoming compact with depth, wet, tarry smell	AQ	9	35	6.10- 6.71	33	10 4 4 7
			AQ	10	35	6.71- 7.31	61	5 2 2 2
			AQ	11	35	7.31- 7.92	41	5 6 7 9



Drilling Report

JOB P8186.00

HOLE BH-2

SHEET 3 OF 3

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u>			<u>Depth</u> (m)	<u>Ret'd</u> (cm)	<u>Pene- tration Test</u>
			<u>*Type</u>	<u>No.</u>	<u>Size</u> (mm)			
7.97	Sandy silt	Light reddish brown and gray mottled sandy silt, some fine gravel, trace clay, compact and moist becoming dense and dry with depth (till)	AQ	12	35	7.92-	61	8
						8.53		7 16 10
			AQ	13	35	8.53-	28	8
						9.14		19 25 34
9.14		End of borehole						

Notes:

1. Samples AQ8 and AQ9 divided into the following two subsamples:
 - AQ8A - top 25 cm of light orangey brown medium sand size slag particles
 - AQ8B - bottom 6 cm of black fine sand size slag particles, tarry smell
 - AQ9A - top 10 cm of light orangey brown fine sand size slag particles
 - AQ9B - bottom 23 cm of dark brownish black medium sand size particles, tarry smell



Drilling Report

JOB P8186.00
HOLE BH-3
SHEET 1 OF 3

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 10:30 Nov. 18, 1988

FINISHED 14:15 Nov. 18, 1988

METHOD OF SOIL DRILLING: Hollow stem auger

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

GROUND SURFACE 8.5 m

BEARING N/a

ROCK SURFACE N/e

INITIAL DIP Vertical

BOTTOM OF HOLE -1.86 m

OTHER DIPS N/a

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.	Size (mm)			
0.0	Coal and slag (fill)	Heterogeneous mixture of black fine sand to fine gravel size coal and slag particles and dark brown sandy silt, some gravel, trace clay, compact, wet	AQ	1	35	0.00-	36	2
						0.61		3
								9
								11
1.00	Sandy silt (fill)	Light reddish brown sandy silt, some gravel, trace clay, loose, moist	AZ	2	35	0.61-	36	11
						1.22		23
			AZ	3	35	1.52-	20	9
						2.13		5

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrel

E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-3

SHEET 2 OF 3

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			*Type	No.	Size (mm)			
	Sandy silt (cont'd)		A	4	35	2.13- 2.74	0	6 5 4 3
			AZ	5	35	3.05- 3.66	33	3 2 4 3
		3.7 - 4.0: coarse gravel						
4.10	Silty sand (fill)	Dark grayish brown silty sand, some gravel, occasional wood frag- ments, loose, moist	AZ	6	35	3.66- 4.27	25	11 24 7 4
			AZ	7	35	4.57- 5.18	13	2 3 1 2
5.54	Sandy gravel (fill)	Light reddish brown sandy gravel, some silt, compact, moist	AQ	8	35	5.18- 5.79	38	3 5 8 7
			AZ	9	35	6.10- 6.71	5	4 11 9 9
			AZ	10	35	6.71- 7.31	20	8 7 6 11
7.50	Coal and slag (fill)	Heterogeneous mixture of black and white coarse sand to fine gravel size coal and slag particles, compact moist	AQ	11	35	7.62- 8.23	41	7 8 8 9
		9.45 - 9.75 tarry smell	AQ	12	35	8.23- 8.84	36	6 9 5 3



Drilling Report

JOB P8186.00

HOLE BH-3

SHEET 3 OF 3

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u>			<u>Depth</u> (m)	<u>Ret'd</u> (cm)	<u>Pene- tration Test</u>
			<u>Type</u>	<u>No.</u>	<u>Size</u> (mm)			
	Coal and slag (cont)		AQ	13	35	9.14-	53	12
						9.75		14
								16
								18
			A	14	35	9.75-	0	12
						10.36		14
								10
								11
10.36		End of borehole						

Notes:

1. Sample AQ13 divided into the following two subsamples:

AQ13A - top 30 cm of black and white coarse sand size coal and slag particles

AQ13B - bottom 23 cm of black fine gravel size coal particles with some sands,
tarry smell



Drilling Report

JOB P8186.00
HOLE BH-4
SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment
PROJECT Sydney Tar Ponds Clean Up
SITE Muggah Creek Shoreline Investigation
CONTRACTOR: Longyear Canada Inc. STARTED 08:00 Nov. 21, 1988
FINISHED 09:00 Nov. 21, 1988
METHOD OF SOIL Hollow stem auger CASING DIAM
DRILLING: ROCK N/a CORE DIAM N/a
LOCATION: LATITUDE see Figure 1 ELEVATIONS: DATUM Canadian Geodetic
DEPARTURE DRILLING PLATFORM
BEARING N/a GROUND SURFACE 1.7 m
INITIAL DIP Vertical ROCK SURFACE N/e
OTHER DIPS N/a BOTTOM OF HOLE -2.26 m
WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample		Size (mm)	Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.				
0.0	Slag and coal (fill)	Heterogeneous mixture of dark brown silt. to fine gravel-size slag and coal particles, some brick and wood fragments, loose to compact, moist becoming wet with depth	AZ	1	35	0.00-	51	2
						0.61		8
								7
								6
			AQ	2	35	0.61-	46	6
2.08	Gravel	Black coal tar coated wood fragments and fine gravel, compact, slight tarry smell				1.22		4
								5
								4
			AQ	3	35	1.52-	28	1
						2.13		1
								3
								2

SAMPLING METHOD

A - split tube
B - thin wall tube
C - piston sampler
D - core barrel
E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

LOGGED BY B. G. Bennett

APPROVED

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-4

SHEET 2 OF 2

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			*Type	No.	Size (mm)			
2.41	Sandy silt	Dark brown sandy silt, some gravel, trace clay, compact, moist, low plasticity (till)	AQ	4	35	2.13- 2.74	48	9
								8
								9
								10
			AZ	5	35	3.05- 3.66	38	7
								6
								5
								5
			AZ	5	35	3.66- 3.96	28	10
								22/30cm
3.96		End of borehole						

Notes:

1. Sample AQ3 divided into the following two subsamples:

AQ 3A - top 23 cm of dark brown sand to gravel size slag particles

AQ 3B - bottom 5 cm of black wood fragments, slight tarry smell



Drilling Report

JOB P8186.00
HOLE BH-5
SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment
PROJECT Sydney Tar Ponds Clean Up
SITE Muggah Creek Shoreline Investigation
CONTRACTOR: Longyear Canada Inc.

STARTED 11:15 Nov. 20, 1988
FINISHED 12:30 Nov. 20, 1988

METHOD OF SOIL Hollow stem auger
DRILLING:

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1
DEPARTURE
BEARING N/a
INITIAL DIP Vertical
OTHER DIPS N/a

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM
GROUND SURFACE 1.7 m
ROCK SURFACE N/e
BOTTOM OF HOLE -2.87 m
WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample		Size (mm)	Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.				
0.0	Asphalt	Asphalt pavement						
0.05	Concrete, slag and coal (fill)	Heterogeneous mixture of light gray fine gravel size concrete and slag fragments and black fine sand size coal particles, compact, dry	AQ	1	35	0.30- 0.91	46	4 5 5 7
1.25	Coke/ coal	Black silt to fine sand size coke/coal particles, very loose, wet, tarry	AZ	2	35	0.91- 1.52	13	11 8 2 1
			A	3	35	1.52- 2.13	0	1/31 cm 1 1

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - open barrel

E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-5

SHEET 2 OF 2

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			*Type	No.	Size (mm)			
2.41	Sand	Light brownish gray fine to medium sand, some wood fragments, very loose, wet	AQ	4	35	2.13- 2.74	56	2
								1
								3
								2
			AQ	5	35	3.05- 3.66	53	1/31 cm
								1
								9
4.34	Sandy silt	Light reddish brown and gray mottled sandy silt, trace clay, dense, dry (till)	AQ	6	35	3.96- 4.57	61	2
								5
								13
								22
4.57		End of borehole						

Notes:

1. Sample AQ 4 divided into the following two subsamples:

AQ 4A - top 23 cm of black silt and fine sands, tarry smell

AQ 4B - bottom 33 cm of light brownish gray fine to medium sand



Drilling Report

JOB P8186.00

HOLE BH-6

SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 10:00 Nov. 20, 1988

FINISHED 10:45 Nov. 20, 1988

METHOD OF SOIL Hollow stem auger
DRILLING:

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

BEARING N/a

GROUND SURFACE 2.0 m

INITIAL DIP Vertical

ROCK SURFACE N/e

OTHER DIPS N/a

BOTTOM OF HOLE -0.74 m

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.	Size (mm)			
0.0	Asphalt	Asphalt pavement						
0.05	Clayey silt with coal (fill)	Heterogeneous mixture of light gray and yellow clayey silt and black coarse sand to fine gravel size coal frag- ments, compact, dry becoming wet with depth	AZ	1	35	0.30- 0.91	56	3 7 9 8
1.21	Clayey silt	Dark gray clayey silt (organic), some wood fragments, firm, moist	AQ	2	35	0.91- 1.52	37	7 3 2 5
1.30	Sandy silt	Light brownish gray sandy silt, trace clay, occasional roots, firm, low plasticity						

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrelE - auger
F - wash

SHIPPING CONTAINER

N - insert R - cloth bag
O - tube S - plastic bag
P - water content tin V - core box
Q - glass jar Z - discarded

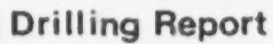
INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



JOB P8186.00

HOLK BH-6

SHEET 2 OF 2

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u>					<u>Pene- tration Test</u>
			<u>*Type</u>	<u>No.</u>	<u>Size</u> (mm)	<u>Depth</u> (m)	<u>Ret'd</u> (cm)	
1.68	Silty sand	Light reddish brown and gray mottled silty fine sand, some gravel, trace clay, compact, moist (till)	AQ	3	35	1.52- 2.13	51	3
								7
								8
								8
2.74		End of borehole	AZ	4	35	2.13- 2.74	33	7
								15
								14
								16



Drilling Report

JOB P8186.00
HOLE BH-7
SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment
PROJECT Sydney Tar Ponds Clean Up
SITE Muggah Creek Shoreline Investigation
CONTRACTOR: Longyear Canada Inc.

STARTED 16:00 Nov. 20, 1988
FINISHED 17:00 Nov. 20, 1988

METHOD OF SOIL DRILLING: Hollow stem auger

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1
DEPARTURE
BEARING N/a
INITIAL DIP Vertical
OTHER DIPS N/a

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM
GROUND SURFACE 2.3 m
ROCK SURFACE N/e
BOTTOM OF HOLE -1.28 m
WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.	Size (mm)			
0.0	Asphalt	Asphalt pavement						
0.05	Gravel (fill)	Light gray fine gravel size slag fragments, dense, dry becoming wet with depth, sulfur smell	AZ	1	35	0.30- 0.53	18	20 24/23cm
			AQ	2	35	0.91- 1.52	43	7 19 23 19
1.70	Sandy silt	Dark gray sandy silt (organic), some clay, firm, wet	AQ	3	35	1.52- 2.13	50	4 5 8 18
1.76	Gravelly sand	Dark brown becoming light brown with depth gravelly fine sand, some silt, compact to dense, wet	AZ	4	35	2.13- 2.74	42	15 19 31 26

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - cws barrel

E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1988



Drilling Report

JOB P8186.00

HOLE BH-7

SHEET 2 OF 2

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u> <u>#Type</u>	<u>No.</u>	<u>Size</u> (mm)	<u>Depth</u> (m)	<u>Ret'd</u> (cm)	<u>Pene-</u> <u>tration</u> <u>Test</u>
2.90	Sandy silt	Light reddish brown sandy silt, some gravel, trace clay, dense, moist (till)	AQ	5	35	3.05- 3.58	33	4 13 27 20/53cm
3.58		End of borehole						



Drilling Report

JOB P8186.00
HOLE BH-8
SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 10:45 Nov. 19, 1988

FINISHED 14:45 Nov. 19, 1988

METHOD OF SOIL Hollow stem auger
DRILLING:

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

BEARING N/a

GROUND SURFACE 6.1 m

INITIAL DIP Vertical

ROCK SURFACE N/e

OTHER DIPS N/a

BOTTOM OF HOLE -3.65 m

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.	Size (mm)			
0.0	Coal and slag	Heterogeneous mixture of black coarse sand to fine gravel size coal fragments and yellowish red fine to medium sand size slag particles, some coarse gravel, loose to compact, dry	AZ	1	35	0.00-	31	4
						0.61		6
			AQ	2	35	1.52-	61	11
						2.13		7
2.60	Coal	Black medium sand to fine gravel size coal particles, loose, dry becoming wet with depth	AQ	3	35	3.05-	33	2
						3.66		3
			AQ	4	35	4.57-	34	6
						5.18		9
5.03	Slag	Light reddish brown coarse sand to fine gravel size slag particles, loose, wet	AQ	4	35	4.57-	34	3
						5.18		3
								5
								7

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrel

E - auger
F - wash

SHIPPING CONTAINER

N - insert
O - tube
P - water content tin
Q - glass jar
R - cloth bag
S - plastic bag
Y - core box
Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-8

SHEET 2 OF 2

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u>			<u>Depth</u> (m)	<u>Ret'd</u> (cm)	<u>Pene- tration Test</u>
			<u>*Type</u>	<u>No.</u>	<u>Size</u> (mm)			
5.65	Coal	Black medium to coarse sand size coke/coal particles, loose, wet, tarry with depth	AQ	5	35	6.10- 6.71	38	6 7 9 6
8.08	Clayey silt	Light brown clayey silt (organic), occasional wood fragments, firm, moist	AQ	6	35	7.62- 8.23	61	5 6 3 3
8.70	Sandy silt	Light reddish brown and greenish gray mottled sandy silt, some fine gravel, trace clay, dense, moist (till)	AQ	7	35	9.14- 9.75	23	7 17 17 19
9.75		End of borehole						

Notes:

1. Sample AQ 6 divided into the following two subsamples:

AQ 6A - top 46 cm of black medium sand size coke/coal particles, tarry smell, fluorescent sheen

AQ 6B - bottom 15 cm of light brown clayey silt



Drilling Report

JOB P8186.00

HOLE BH-9

SHEET 1 OF 2

CLIENT Nova Scotia Department of the Environment

PROJECT Sydney Tar Ponds Clean Up

SITE Muggah Creek Shoreline Investigation

CONTRACTOR: Longyear Canada Inc.

STARTED 15:15 Nov. 19, 1988

FINISHED 16:30 Nov. 19, 1988

METHOD OF SOIL Hollow stem auger
DRILLING:

CASING DIAM

ROCK N/a

CORE DIAM N/a

LOCATION: LATITUDE see Figure 1

ELEVATIONS: DATUM Canadian Geodetic
DRILLING PLATFORM

DEPARTURE

BEARING N/a

GROUND SURFACE 1.7 m

INITIAL DIP Vertical

ROCK SURFACE N/e

OTHER DIPS N/a

BOTTOM OF HOLE -2.57 m

WATER LEVEL N/r

Depth (m)	Soil Type	Description	Sample			Depth (m)	Ret'd (cm)	Pene- tration Test
			Type*	No.	Size (mm)			
0.0	Brick and slag	Heterogeneous mixture of brick fragments and light reddish brown coarse sand to fine gravel size slag particles, compact, wet	AQ	1	35	1.52- 2.13	25	11 9 8 16
1.95	Gravel	Black coal-tar coated fine gravel, some fine sand, trace silt, loose to compact, wet	AQ	2	35	2.44- 3.05	31	6 3 5 7
3.38	Sandy silt	Light reddish brown sandy silt, trace clay, compact, moist (till)	AQ	3	35	3.05- 3.66	46	2 8 10 7

SAMPLING METHOD

*A - split tube
B - thin wall tube
C - piston sampler
D - core barrelE - auger
F - wash

SHIPPING CONTAINER

N - insert R - cloth bag
O - tube S - plastic bag
P - water content tin Y - core box
Q - glass jar Z - discarded

INSPECTOR B. G. Bennett

APPROVED

LOGGED BY B. G. Bennett

DATE

February 1989



Drilling Report

JOB P8186.00

HOLE BH-9

SHEET 2 OF 2

<u>Depth</u> (m)	<u>Soil Type</u>	<u>Description</u>	<u>Sample</u>			<u>Depth</u> (m)	<u>Ret'd</u> (cm)	<u>Pene- tration Test</u>
			<u>*Type</u>	<u>No.</u>	<u>Size</u> (mm)			
	Sandy		AQ	4	35	3.66-	38	9
	silt					4.27		10
	(cont)							12
								12
4.27		End of borehole						

Notes:

1. Sample AQ 3 divided into the following two subsamples:

AQ 3A - top 18 cm of black silt and fine sands, tarry smell

AQ 3B - bottom 28 cm of light reddish brown sandy silt

